radiant assigned to Comet III., 1862, viz. $43° + 57°\cdot5$ (Herschel), and $43°\cdot8 + 57°\cdot2$ (Corrigan).

Orionids.—Profs. Schmidt and Herschel were the first to discover the Orionids as the most brilliant display of the October period, and accurately determined its radiant in 1863–4–5. Herrick recorded a shower at $99° + 26°$, Oct. 20–26, 1839, and Zezioli in 1868 recorded many meteors which were ascribed to a radiant at $111° + 29°$, but there is no doubt that the Orionids were observed in both these cases, though the radiant was badly assigned. There is a contemporary shower at $106° + 22°$, close to δ *Geminorum*, which is liable to be confused with the Orionids, but the latter is by far the richest of the pair. The radiant of the Orionids shows no displacement like the Perseids.

Leonids.—Observed from the earliest times. Humboldt and Bonpland saw it well on the night of November 11–12, 1799, and the phenomenon at its magnificent return on November 12, 1833, was ably discussed by Olmsted. It furnished a splendid shower in 1866, November 13, and many meteors were seen at the few subsequent returns. During the last fifteen years the displays have been extremely meagre. There is no doubt, however, that the meteors form a complete ellipse, for the earth encounters a few of the particles at every passage through the node. But the meteors are nearly all massed in the neighbourhood of their parent, Comet I. 1866, which gives a radiant at $150\cdot5 + 23\cdot5$, November 13 (Herschel), and $150°\cdot4 + 22°\cdot8$ (Corrigan). It is supposed that there are minor groups of meteors pursuing the same orbit; if so we may have a revival of this display in 1888, for "on the night of November 12, 1822, shooting stars mingled with balls of fire were seen in vast numbers at Potsdam by Klöden" (Lardner's *Museum*).

Andromedes.—Observed by Brandes, at Hamburg, December 7, 1798. It also recurred in 1838; the very brilliant showers of November 27, 1872 and 1885, are still fresh in the memory. It is uncertain whether this group forms an unbroken stream; if so, the regions far removed from the comet must be extremely attenuated. Some of the meteors were seen in 1877 and 1879. The radiant is diffuse to the extent of 7° or 10°. The cometary radiant is at $23°\cdot4 + 43°\cdot4$ (Weiss), and $24° + 43°\cdot2$ * (Corrigan), which is very close to the meteoric centre. Returns of the shower should be looked for in 1892 and 1898.

Geminids.—Mr. Greg first called attention to the importance of this shower. It was well observed by Prof. Herschel in 1861–3–4, and some later years.

Bristol: 1887, *December.*

Heights of Fireballs and Shooting Stars. By W. F. Denning.

While occasionally engaged during the past year in computing meteor heights, I was led to compare the relative elevations of fireballs and ordinary shooting stars. The former before extinction appear to penetrate much lower in the air than the latter. From the real paths of the fireballs and smaller meteors seen by myself and other members of the Liverpool Astronomical Society at the end of 1886 and during 1887, it appears that the height of fireballs at disappearance is only about one-half that of shooting stars, the figures being 25 and 54 miles respectively. But these values are based on only 20 observations, and are, therefore, far from being conclusive. They are, however, amply

* These positions by Mr. Corrigan are taken from the *Sidereal Messenger*, May 1886.

confirmed by numerous records contained in the *Luminous Meteor Reports of the British Association*, the *Monthly Notices*, Heis's *Resultate der in den* 43 *Jahren* 1833–1875 *angestellten Sternschnuppen-Beobachtungen*, and other publications.

The mean heights, in British statute miles, of the best observed and most brilliant fireballs of the last twenty years or so, as computed by Prof. Herschel, Col. Tupman, and many others, and described in consecutive volumes of the *B. A. Reports*, *Monthly Notices*, &c., are as follow :—

	Height at beginning.	Height at ending.
80 fireballs, 1865–1887	69·2 miles	30·2 miles

Let us compare with these figures the mean heights of meteors (nearly all shooting stars of the 1st mag., or fainter) which I have derived from a collection of the results given by several different authorities :—

	No. of Meteors.	Height at beginning.	Height at ending.
E. Heis, *Resultate, &c.*	271	76·9 miles	50·1 miles
A. S. Herschel, *B. A. Reports*	86	79·5 „	53·3 „
T. H. Waller, *B. A. Report*, 1874	48	81·4 „	52·4 „
W. F. Denning, shooting stars seen in 1887	13	80·0 „	54·2 „

The average height of nearly all the meteors seen up to the end of 1862 (*B. A. Report*, 1863, p. 328) was—

At beginning.	At ending.
70·05 miles	54·22 miles.

These, however, included a proportion of fireballs. The mean heights deduced from the calculations of Heis, Herschel, and Waller, given in the above summary, are 79·3 and 51·9 miles, but a few fireballs were interspersed amongst these observations (though the great bulk of them consists of ordinary shooting stars), hence the values are perhaps slightly below the elevations that would be derived from the smaller meteors alone. A careful discussion of the various records gives the following mean relative heights :—

	At beginning.	At ending.	At mid-course.
Fireballs	69 miles	30 miles	$49\frac{1}{2}$ miles
Shooting stars	80 „	54 „	67 „

It appears from this that before attaining a visible degree of incandescence fireballs are usually eleven miles lower in the atmosphere than small meteors, and that upon final disruption they are twenty-four miles nearer the earth than the fainter class. The heights at mid-course differ by nearly eighteen

miles. It is also extremely probable that telescopic meteors are at yet greater elevations than the brighter forms of these bodies visible to the naked eye.

Bristol: 1887, *December*.

On Invisible Stars of Perceptible Actinic Power.
By Dr. R. de Kövesligethy.

(*Communicated by the Astronomer-Royal.*)

With reference to his well-known photographs of the small star in the annular nebula in *Lyra*, M. von Gothard was so kind as to call my attention to the possibility of a theoretical treatment of the question as to the existence of invisible stars of perceptible actinic power. The question may be generally resolved without the aid of any explicit law of emission. As I think the results may be of some importance as bearing upon the proposed photographic work shortly to be undertaken, I may be allowed to briefly point them out.

I exclude all stars of *merely* homogeneous ultra-violet light, not only because these cases may be very rare, but chiefly because the invisibility of such a star would be of no further account. I select rather stars of well-developed continuous spectra. Then, to speak briefly, I consider two methods of photometric observations as *different* when they select out of the spectrum a group of rays between *different* limits of wave-length. Thus eye observations and photographs of stars are regarded as different, the former limiting the star's spectrum between the Fraunhofer lines H and A, and the latter between about P and *b*. The influence of different sensibility of the two methods may be omitted, for it does not alter at all the following theoretical theses:—

(1) For two proposed methods of observation there exists at least one substance giving a continuous spectrum such that the total intensity of the light between defined limits is the same by both methods, or conversely.

(2) For any substance giving a continuous spectrum there are at least two methods of observation for which the intensity of the light within defined limits has the same value.

The theorem is evidently demonstrated if I could prove that the emission function contains at least two parameters not simultaneously eliminable.

Let I be the intensity of the ray of wave-length λ, θ the absolute temperature, $z_1, z_2 \ldots z_n$ certain quantities depending